

2.9 GEOLOGY / SOILS / SEISMIC / TOPOGRAPHY

This section also discusses geology, soils, and seismic concerns as they relate to public safety and project design. Earthquakes are prime considerations in the design and retrofit of structures. The Department's Office of Earthquake Engineering is responsible for assessing the seismic hazard for Department projects. The current policy is to use the anticipated Maximum Credible Earthquake (MCE), from young faults in and near California. The MCE is defined as the largest earthquake that can be expected to occur on a fault over a particular period of time.

The information below is summarized from the Preliminary Geologic/Geotechnical Feasibility Studies prepared by Kleinfelder. These reports are available for public review at Caltrans District 4, 111 Grand Avenue, Oakland, CA 94610, and the Solano Transportation Authority, One Harbor Center, Suite 130, Suisun City, CA 94585 during normal business hours.

Regulatory Setting

For geologic and topographic features, the key federal law is the Historic Sites Act of 1935, which establishes a national registry of natural landmarks and protects "outstanding examples of major geological features." Topographic and geologic features are also protected under the California Environmental Quality Act.

Affected Environment

Regional Geology

The project area is located in the hills bordering the northwesterly margin of the intertidal estuary northwest of Grizzly Bay, along the northeasterly edge of the Coast Range Geomorphic Province of California. The Coast Ranges Province is a geologically complex and seismically active region characterized by sub-parallel northwest-trending faults, mountain ranges, and valleys. The topography within this province varies from gently sloping foothills to steep mountain flanks.

West End

Local Geology. The West End is underlain by the Markley Sandstone of the Kreyenhagen Formation. The Markley Sandstone generally consists of poorly consolidated silty sandstones, crudely interbedded with sandy siltstone and claystone, and was deposited rapidly in a deep submarine canyon. Due to its rapid deposition, bedding in the Markley may be variable and discontinuous, with lensing of material.

Faulting and Seismicity. The West End Alignment is located between 0.5 to 1.3 miles west of the Cordelia fault zone, which is considered to be potentially active, and has been included in the Alquist-Priolo Earthquake Fault Zone map for the Cordelia quadrangle. The Cordelia fault zone is generally considered to be part of the San Andreas Fault system, and is a relatively minor fault zone compared to the major fault zones of the San Andreas system.

The Green Valley and Cordelia faults are the only active faults known to show surface displacement within Solano County. It is likely that a pattern of seismicity similar to historic seismicity will persist into the foreseeable future. The probability of a magnitude 6.7 or greater earthquake occurring somewhere in the Bay region, on one of the major

faults of the San Andreas fault system in the 30 year period ending in 2030, is estimated to be 70 percent or greater. To minimize potential structural distress, the project should be designed and constructed according to the most current earthquake resistance standards for Seismic Zone 4, as outlined in the current Uniform Building Code.

Of greater significance to the project is the active Green Valley fault, which crosses the subject alignment. The Green Valley fault extends at least 19 miles northwest from Bahia on Suisun Bay northward to Wooden Valley.

A paleoseismic study was conducted across the western three traces of the Green Valley, as mapped by Hart and Bryant (1977), on the property immediately south of Freehorn Creek and east of Red Top Road at the southern end of the proposed North Connector, by Borchard and others (2001). That study found no evidence of Holocene age, shears or offsets indicative of active faulting on that site. Kleinfelder (2002) performed a geologic fault investigation for a PG&E gas pipeline replacement project that crosses the Mangels Ranch north of Highway 12. That study included geophysical profiling and trenching and identified two active traces of the Green Valley fault. The faults exposed in the trenches of that study were characterized by zones of sheared bedrock 20 to 30 feet wide with prominent shears bounding the zone. In the proposed project area north of Highway 12, the two fault splays were identified in the same general location as those shown by Hart and Bryant (1997). The potential for ground rupture within the identified fault zones (Kleinfelder 2002) is high and possible future ground shearing is considered in a zone 50 feet on either side of the identified fault zone. Therefore, the potential for future surface fault rupture in the project area is high.

Landslide Deposits. Large-scale landslides have been mapped in the general vicinity of the West End Alignments. There is a large, ancient landslide mass immediately west of the project. The ridgeline is classified as being marginally susceptible to the occurrence of debris flow with the highest areas being those underlain by Markley Sandstone. The slopes in the area of the ridgeline should be considered naturally unstable.

Central Section

Local Geology. The Central Section of the project area is underlain by Sonoma Volcanics. The Sonoma Volcanics are mapped as being comprised of andesitic to basaltic flows, ash flow tuffs and rhyolitic flows. The geology of the Central Section is similar to that of the East End.

East End

Local Geology. The East End of the study area is underlain by Holocene fan deposits, which are projected to be underlain at depth by Jurassic-Cretaceous age Great Valley Sequence of sedimentary bedrock. The fan deposits are made up of interbedded layers of clay, silts, sands and gravels. These deposits are identified as having low to moderate liquefaction potential.

The subsurface soils are generally consistent within the East End. Surface soils typically consist of moderate to highly plastic silty clays, which have a moderate to high potential for expansion pressures with variations in moisture content. Underlying the surface layers there are alternating layers of sandy silts and silty clays which are considered to be prone to liquefaction during seismic events. Groundwater at the Suisun Creek site was at an approximate elevation of +6 meters.

The East End project area primarily consists of nearly flat and level land currently being utilized for agricultural purposes.

Faulting and Seismicity. The East End project area is located between 1.8 and 3.4 kilometers east of the Cordelia fault zone. Of greater significance to the project is the active Green Valley fault, which is situated 3.8 to 5.3 kilometers west of the East End.

Landslide Deposits. The topography of the East End is flat and level, therefore landslide potential is not considered to be a geologic hazard.

Impacts

West End

Seismic effects, such as lateral spreading and seismically induced settlement, have a high probability of occurring in the project area, especially in the vicinity of Red Top Road.

The roadway will begin at an elevation of 113 feet at the Red Top Road railroad crossing, rise to 146 feet and then drop to about 39 feet elevation at Business Center Drive. Preliminary layout drawings indicate that the West End of the North Connector will have a 7 and 8 percent slope which traverses the ridgeline. The proposed project would cross the Green Valley fault and an existing Pacific Gas and Electric (PG&E) gas main.

Central Section

The proposed project in this area would involve minor grading to realign existing roadways in an area of relatively flat topography. The project in this area would be subject to seismic effects; however land slide effects would be minimal due to the flat topography.

East End

There are existing and/or potential geologic hazards and constraints locally, as well as globally, along the project corridor that need to be taken into account in the planning, design, and construction of the proposed project.

Since the East End is not within an Alquist-Priolo Earthquake Fault and there are no mapped faults that cross the alignment, the potential for damage due to surface rupture or fault-related creep is very low. However, the potential for strong seismic ground shaking in the area is possible, and the project should be constructed in accordance with the current seismic design codes.

Avoidance, Minimization, and Mitigation Measures

Impact GEO 1: Movement along one or more of faults will result in at least one moderate to major earthquake, resulting in strong seismic shaking within the project area during the lifetime of the proposed project.

Mitigation Measure GEO 1: The potential for strong seismic ground shaking shall be taken into account in the design of structures along the subject alignment in accordance with the current seismic design codes.

Impact GEO 2: The potential for ground rupture and possible shearing within the West End is high.

Mitigation Measure GEO 2: To minimize potential structural distress, the project shall be designed and constructed according to the most current earthquake resistance standards for Seismic Zone 4, as outlined in the current Uniform Building Code.

Impact GEO 3: The potential for liquefaction, lateral spreading or lurching to occur is considered to be moderate in the area along Red Top Road.

Mitigation Measure GEO 3: The potential for and the resulting effects of liquefaction and compressible soils shall be further evaluated by the design team prior to finalizing the design and layout of the proposed roadway.

Impact GEO 4: There is a moderate potential for liquefaction in the East End during seismic events.

Mitigation Measure GEO 4a: Any new bridges/overcrossing structures shall be supported upon a deep foundation system, which extends through the potentially liquefiable zones and bears upon the underlying dense gravelly layers.

Mitigation Measure GEO 4b: The potential for lateral spreading or lurching is considered to be low to moderate. However, the potential for and the resulting effects of liquefaction soils shall be further evaluated by a qualified geologist prior to finalizing the design and layout of proposed roadway.

Impact GEO 5: The West End of the North Connector is in an area where large landslides have and can continue to occur.

Mitigation Measure GEO 5: Existing landslides and the potential for inducing landsliding by grading weak soil, colluvial and bedrock materials shall be taken into account in the design of the proposed grading for the project. In addition, geologic mapping and soil/rock borings shall be conducted as part of these investigations.

Impact GEO 6: Inadequate fill material can lead to soil instability and erosion. The on-site bedrock-derived materials, existing fills, and native soils within the project area can be used as general fill throughout the project, provided they do not contain more than 3 percent organic material. Higher organic content in soil mixtures may be permissible in landscape areas. As a result, the use of on-site soils for fill could result in a potentially significant impact.

Mitigation Measure GEO 6a: General fill materials (within 5 vertical feet of proposed improvements) shall generally contain rock fragment no larger than 6 inches in maximum diameter. Placement of larger rock fragments or oversized material is possible at the discretion of the project Geotechnical Engineer or Engineering Geologist in deeper fills, provided that the large fragments are not nested and proper compaction can be achieved. Select fill should have a Plasticity Index of less than 15, a Liquid Limit of less than 40, maximum aggregate size of 4 inches and have 15 percent to 60 percent of the material passing the No. 200 sieve. It is possible that select fill could be generated from portions of the basalt, sandstone and some select tuff layers.

Mitigation Measure GEO 6b: Due to the moderate to highly expansive nature of some materials that will be generated as fill, exposed within cut slopes, or present within the subgrade of the proposed alignment, for planning purposes new cut and fill slopes shall be planned for gradients no steeper than 3:1. Steeper slopes, if required, shall necessitate further investigation, testing, and analysis in order to develop adequate slope design criteria and possible engineered solutions for steeper slopes. Such solutions may include: fill slope construction with select fill; engineered slopes with

geotextile reinforcements; soil improvement additives such as lime; the use of retaining walls; or, a combination thereof.

Mitigation Measure GEO 6c: In general, fills on slopes steeper than 6:1 shall require construction of keyways and benches with sub-drains. Fill and cut slopes shall be constructed in accordance with Caltrans guidelines and be designed with appropriate surface drainage collection facilities and benching for slopes greater than 30 feet in height.

Mitigation Measure GEO 6d: Existing undocumented fills within the proposed alignment shall be removed for their full depth and replaced with compacted engineered fill. Earthen fill materials that do not contain more than 3 percent organics can be re-used as general fill. Organic-rich fill should not be used in areas of proposed roadway or other improvements.

Impact GEO 7: There is the potential for differential settlement resulting from differential fill thicknesses across the project area (West, Central and East), especially existing steep hill slopes.

Mitigation Measure GEO 7: Special consideration shall be given to fill placement techniques in order to minimize the settlement potential of the deep fills. Such techniques may include: increasing relative compaction to a minimum of 95 percent (versus the standard 90 percent); surcharging the fills with additional load and later removal; dynamic compaction; use of geotextiles; or a combination thereof.

Impact GEO 8: The West End Alignment will have slopes and some of the on-site materials are expansive and prone to creep, which is the slow downhill movement of soils and weathered bedrock due to gravity.

Mitigation Measure GEO 8: Maintenance, repair, and/or occasional replacement of the slopes and/or improvements shall be provided for on a yearly basis for the lifetime of the project. Other engineering solutions may also be required to reduce the potential for creep.

Impact GEO 9: Groundwater may be encountered at relatively shallow depths in the vicinity of Jameson Creek and in areas Suisun Creek. Seepage within cutslopes is a concern with respect to erosion and stability of the cutslope face. This is a potentially significant effect in the West End of the project area where cuts and fills will be necessary to construct the new roadway and improvements to the State Route 12/Red Top Road intersection.

Mitigation Measure GEO 9a: Special dewatering procedures for utilities or deep foundations, depending on the time of year of construction, may be required. Special considerations to collect and control seepage, especially at material contacts/faults may be required.

Mitigation Measure GEO 9b: Each proposed cut area shall be evaluated for material stability and excavability, including providing recommended stable slope inclinations. The investigation shall include at least one soil/rock boring and a seismic refraction line per cut area. Borings shall extend to a minimum of 3 meters (10 feet) below depth of proposed cut.

Mitigation Measure GEO 9c: Specific recommendations shall be provided for construction and monitoring fill construction including staged construction, if required. Minimum of two soil borings and/or cone penetrometer tests (CPTs), and one observation well are suggested for the Business Center Drive transition fill area.

Page Left Intentionally Blank